Turbulence induced vibrations: in search of understanding the space-time fluctuating forces.

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Analysis of the vibratory response of structures to the excitation by the fluctuating pressures beneath a turbulent boundary layer has been a topic of intensive research over the past fifty years. Under such an immense effort, some problems remain unsolved, in particularly when flow speeds are much slower than structural wave speeds. The spatial and temporal characteristics of the fluctuating forces are usually expressed in terms of a second moment of the pressure field statistics, such as space-time correlation functions or its Fourier conjugate, wavevector-frequency spectra. These statistical tools have satisfactorily resolved the predominant components of the fluctuating pressures convected with the flows. Unfortunately, in low speed flows, these predominant fluctuating pressures are not primarily responsible for exciting the structural waves propagate at much higher speeds. The primarily responsible exciting pressure forces are not well understood and are believed to be about four orders of magnitude smaller than the convective components. Difficulties in the measurement of and the controversy among prevailing theories about these tinny but efficient components of the fluctuating forces are discussed.